

SHEET 4 & 5

- 1- Let set of tasks to be processed by 1 server, find the average completion time, average service time, average waiting time, using batch schedule and time sharing with slot time =10 time units .

task	1	2	3	4	5	6	7	8	9	10	11	12	13
time	25	22	12	20	2	50	30	10	2	20	40	10	5



USING BATCH FCFS (FIRST COME FIRST SERVICED)

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	25	47	59	79	81	131	161	171	173	193	233	243	122.8
Completion time	25	47	59	79	81	131	161	171	173	193	233	243	248	141.8



USING TIME SHARING,

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 ,	10,	20,	30,	40	42,	52,	62	72	74,	84,	94	104	
Compl et. time	10, 10,	20,	30,	40,	42 #	52,	62,	72 #	74 #	84,	94,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 ,	10,	20,	30,	40	42,	52,	62	72	74,	84,	94	104	
Compl et. time	10,	20,	30,	40,	42 #	52,	62,	72 #	74 #	84,	94,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109,	10, 119,	20, 129	30, 131	40	42, 141,	52, 151,	62	72	74, 161	84, 171,	94	104	
Compl et. time	10, 119,	20, 129,	30, 131 #	40, 141 #	42 #	52, 151,	62, 161,	72 #	74 #	84, 171#	94, 181,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109,	10, 119,	20, 129	30, 131	40	42, 141,	52, 151,	62	72	74, 161	84, 171,	94	104	
Compl et. time	10, 119,	20, 129,	30, 131 #	40, 141 #	42 #	52, 151,	62, 161,	72 #	74 #	84, 171#	94, 181,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188,	52, 151, 198	62	72	74, 161	84, 171, 208	94	104	
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198,	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188,	52, 151, 198	62	72	74, 161	84, 171, 208	94	104	
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198,	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218,	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188, 218,	52, 151, 198	62	72	74, 161	84, 171, 208 228	94	104	
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198, 228,	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218, 238 #	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188, 218,	52, 151, 198	62	72	74, 161	84, 171, 208 228	94	104	
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198, 228,	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218, 238 #	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188, 218, 238	52, 151, 198	62	72	74, 161	84, 171, 208 228	94	104	
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198, 228, 248#	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218, 238 #	104 #	109 #	



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0 , 109, 181	10, 119, 186	20, 129	30, 131	40	42, 141, 188, 218, 238	52, 151, 198	62	72	74, 161	84, 171, 208 228	94	104	140.3
Compl et. time	10, 119, 186 #	20, 129, 188 #	30, 131 #	40, 141 #	42 #	52, 151, 198, 228, 248#	62, 161, 208 #	72 #	74 #	84, 171#	94, 181, 218, 238 #	104 #	109 #	147



- 2- For the last problem using batch system , if tasks have the next priorities, find completion time, average service time, average waiting time

task	1	2	3	4	5	6	7	8	9	10	11	12	13
priority	5	2	2	1	7	1	2	3	2	1	2	4	2
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5
Order of execut.	2	5	6	11	1	12	7	4	8	13	9	3	10



Order of execut.	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
priority	7	5	4	3	2	2	2	2	2	2	1	1	1	
Service time	2	25	10	10	22	12	30	2	40	5	20	50	20	19
Wait time	0	2	27	37	47	69	81	111	113	153	158	178	228	92.6
Comple t. time	2	27	37	47	69	81	111	113	153	158	178	228	248	111. 6

- 3- For the last problem using batch system , if tasks have the priorities that shortest execution task is first serviced (**SEFS**), find completion time, average service time, average waiting time

task	1	2	3	4	5	6	7	8	9	10	11	12	13
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5
Order of execut.	10	9	6	7	1	13	11	4	2	8	12	5	3



Order of execut.	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	2	2	5	10	10	12	20	20	22	25	30	40	50	19
Wait time	0	2	4	9	19	29	41	61	81	103	128	158	198	64
Comple. time	2	4	9	19	29	41	61	81	103	128	158	198	248	83.



- 4- Using 2 parallel processors, in batch system, find the average completion time, average service time, average waiting time

task	1	2	3	4	5	6	7	8	9	10	11	12	13
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0												
Compl. S1	25													
Compl. S2		22												



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22											
Compl. S1	25													
Compl. S2		22	34											



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25										
Compl. S1	25			45										
Compl. S2		22	34											



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34									
Compl. S1	25			45										
Compl. S2		22	34		36									



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36								
Compl. S1	25			45										
Compl. S2		22	34		36	86								



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45							
Compl. S1	25			45			75							
Compl. S2		22	34		36	86								



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75						
Compl. S1	25			45			75	85						
Compl. S2		22	34		36	86								



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75	85					
Compl. S1	25			45			75	85	87					
Compl. S2		22	34		36	86								

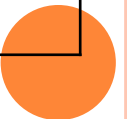


task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75	85	86				
Compl. S1	25			45			75	85	87					
Compl. S2		22	34		36	86				106				



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av .
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75	85	86	87			
Compl. S1	25			45			75	85	87		127			
Compl. S2		22	34		36	86				106				

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75	85	86	87	106		
Compl. S1	25			45			75	85	87		127			
Compl. S2		22	34		36	86				106		116		



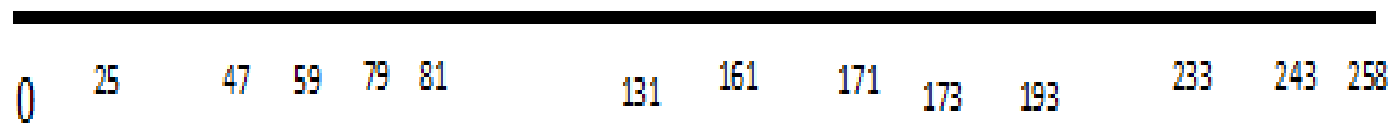
task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
Service time	25	22	12	20	2	50	30	10	2	20	40	10	5	19
Wait time	0	0	22	25	34	36	45	75	85	86	87	106	116	55.2
Compl. S1	25			45			75	85	87		127			74.2
Compl. S2		22	34		36	86				106		116	121	

- 5- Using 2 serial processors, find the average completion time, average service time, average waiting time

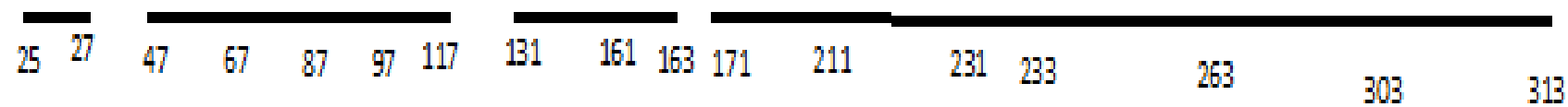
task	1	2	3	4	5	6	7	8	9	10	11	12	13
S1	25	22	12	20	2	50	30	10	2	20	40	10	15
S2	2	20	20	10	20	30	2	40	20	2	30	40	10



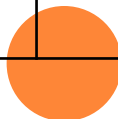
S1



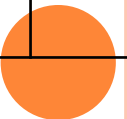
S2



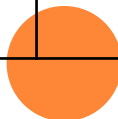
task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0													
Wait s2														
Comp. s1	25													
Comp. S2														



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0													
Wait s2	25													
Comp. s1	25													
Comp. S2	27													



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25												
Wait s2	25													
Comp. s1	25	47												
Comp. S2	27													



[illegible]

[illegible]

[illegible]

[illegible]

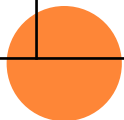
[illegible]

[illegible]

[illegible]

[illegible]

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81								
Wait s2	25	47	67	87	97	131								
Comp. s1	25	47	59	79	81	131								
Comp. S2	27	67	87	97	117	161								

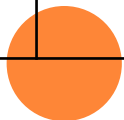


task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131							
Wait s2	25	47	67	87	97	131								
Comp. s1	25	47	59	79	81	131	161							
Comp. S2	27	67	87	97	117	161								

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131							
Wait s2	25	47	67	87	97	131	161							
Comp. s1	25	47	59	79	81	131	161							
Comp. S2	27	67	87	97	117	161	163							

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131	161						
Wait s2	25	47	67	87	97	131	161							
Comp. s1	25	47	59	79	81	131	161	171						
Comp. S2	27	67	87	97	117	161	163							

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131	161						
Wait s2	25	47	67	87	97	131	161	171						
Comp. s1	25	47	59	79	81	131	161	171						
Comp. S2	27	67	87	97	117	161	163	211						



task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131	161	171					
Wait s2	25	47	67	87	97	131	161	171						
Comp. s1	25	47	59	79	81	131	161	171	173					
Comp. S2	27	67	87	97	117	161	163	211						

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131	161	171					
Wait s2	25	47	67	87	97	131	161	171	211					
Comp. s1	25	47	59	79	81	131	161	171	173					
Comp. S2	27	67	87	97	117	161	163	211	231					

task	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.
S1	25	22	12	20	2	50	30	10	2	20	40	10	15	19.8
S2	2	20	20	10	20	30	2	40	20	2	30	40	10	18.9
Wait s1	0	25	47	59	79	81	131	161	171	173	193	233	243	122.8
Wait s2	25	47	67	87	97	131	161	171	211	231	233	263	303	155.9
Comp. s1	25	47	59	79	81	131	161	171	173	193	233	243	258	142.6
Comp. S2	27	67	87	97	117	161	163	211	231	233	263	303	313	174.8

SHEET 4

- 8- regarding process management, A program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction,
- Determine :
- 1-the effective CPI (cycles per instruction)
- 2-MIPS (million instructions per sec) rate
- 3- execution time for this program.

Instruction Type	Instruction Count	Cycles per Instruction
Integer arithmetic	45000	1
Data transfer	32000	2
Floating point	15000	2
Control transfer	8000	2

←=100000

- Rate of processor = 40 MHZ
- Effective CPI = total no. of cycles per instruction /no. of instructions
$$=(45000*1 + 32000*2 + 15000*2 + 8000*2)/100000$$
$$= 1.55$$
- Cycle time = $1/\text{rate} = 1/40\text{M} = 0.025$ micro sec
- Rate of IPS = rate/ effective CPI
$$=(40\text{M cycle/s}) / (1.55 \text{ C/I}) = 25.8 \text{ M I/s}$$
- Time per instruction = $1/\text{Rate of IPS} = 0.03875$ micro-sec
- Execution time of program = number of instructions * time per instruction
$$= 100000 * 0.03875 = 3875 \text{ micro sec}$$



- **9- Consider two different computers, with two different instruction sets, both of which have a clock rate of 4200 MHz. The following measurements are recorded on the two computers running a given set of benchmark programs: Determine the effective CPI, MIPS rate, and execution time for each machine.**



Instruction Type	Instruction Count (millions)	Cycles per Instruction
Machine A		
Arithmetic and logic	8	1
Load and store	4	3
Branch	2	4
Others	4	3
Machine B		
Arithmetic and logic	10	1
Load and store	8	2
Branch	2	4
Others	4	3



COMPUTER A

- Effective CPI = $(8*1 + 4*3 + 4*2 + 4*3)/18 = 2.2$
- Cycle time = $1/4200\text{M} = 0.238 \text{ n-sec}$
- Rate of IPS = $(4200\text{M cycle/s}) / (2.2 \text{ C/I}) = 1909 \text{ M I/s}$
- Time per instruction = $1 / \text{rate of IPS} = 0.524 \text{ n-sec}$
- Execution time of program = number of instructions * time per instruction
- $= 18000000 * 0.524 = 0.0094 \text{ milli sec} = 9.4 \text{ micro sec}$



COMPUTER B

- Effective CPI for computer B= $(10*1 + 8*2 + 4*2 + 4*3) / 24 = 1.92$
- Cycle time= $1/4200\text{M} = 0.238 \text{ n-sec}$
- Rate of IPS= $(4200\text{M cycle/s}) / (1.92 \text{ C/I}) = 2191 \text{ M I/s}$
- Time per instruction = $1 / \text{rate of IPS} = 0.456 \text{ n-sec}$
- Execution time of program = number of instructions * time per instruction = $24000000 * 0.456 = 10.952 \text{ micro sec}$



- 11- Four programs are executed on three computers with the following results, The table shows the execution time in seconds, with 100,000,000 instructions executed in each of the four programs. Calculate the MIPS values for each computer for each program.

	Computer A	Computer B	Computer C
Program 1	1	10	20
Program 2	1000	100	20
Program 3	500	1000	50
Program 4	100	800	100

Execution time of program1 = number of instructions * time per instruction

1 = 100 million instruction * time per instruction

Time per instruction=1 / 100million

Rate of IPS = 1 / Time per instruction= 100 million instruction per second (MIPS)

MIPS	Computer A	Computer B	Computer C
Program 1	100	10	5
Program 2	0.1	1	5
Program 3	0.2	0.1	2
Program 4	1	0.125	1



- 12- The following table, shows the execution times, in seconds, for five different programs on three machines, Compute the speed metric for each processor. Which computer is the slowest ,



Benchmark	Processor		
	R	M	Z
E	417	244	134
F	83	70	70
H	66	153	135
I	39,449	35,527	66,000
K	772	368	369

- Average time of processor R =
- $(417 + 83 + 66 + 39449 + 772) / 5 = 1377.449$
- Average time of processor M = 719.057
- Average time of processor Z = 66708
- Processor Z is the slowest .
- Processor M takes the least average time to execute the 5 programs, so it is the fastest,

